TAMAYA

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TAMAYA
DIGITAL NAVIGATION
COMPUTER

NC-77

INSTRUCTION MANUAL

TAMAYA

TABLE 1 **1978 S.D. Sun / H.P. Venus and Mars**

S.D. Sun ☉

Jan	1	– Feb	2		16′.3
Feb	3	– Mar	4		16.2
Mar	5	– Mar	28		16.1
Mar	29	– Apr	18		16.0
Apr	19	– May	12		15.9
May	13	– Aug	25		15.8
Aug	26	– Sep	18		15.9
Sep	19	– Oct	12		16.0
Oct	13	– Nov	2		16.1
Nov	3	– Dec	2		16.2
Dec	3	– Dec	31		16.3

H.P. Venus ♀

Jan	1	– Jul	23	0′.1
Jul	24	– Sep	10	0.2
Sep	11	– Oct	3	0.3
Oct	4	– Oct	19	0.4
Oct	20	– Nov	29	0.5
Nov	30	– Dec	14	0.4
Dec	15	– Dec	31	0.3

H.P. Mars ♂

Jan	1	– Mar	19	0′.2
Mar	20	– Dec	31	0.1

CAUTION

It is imperative that nautical almanac, sight reduction tables and other conventional navigational aids be kept aboard along with the NC-77 computer as insurance against computer failure or battery discharge.

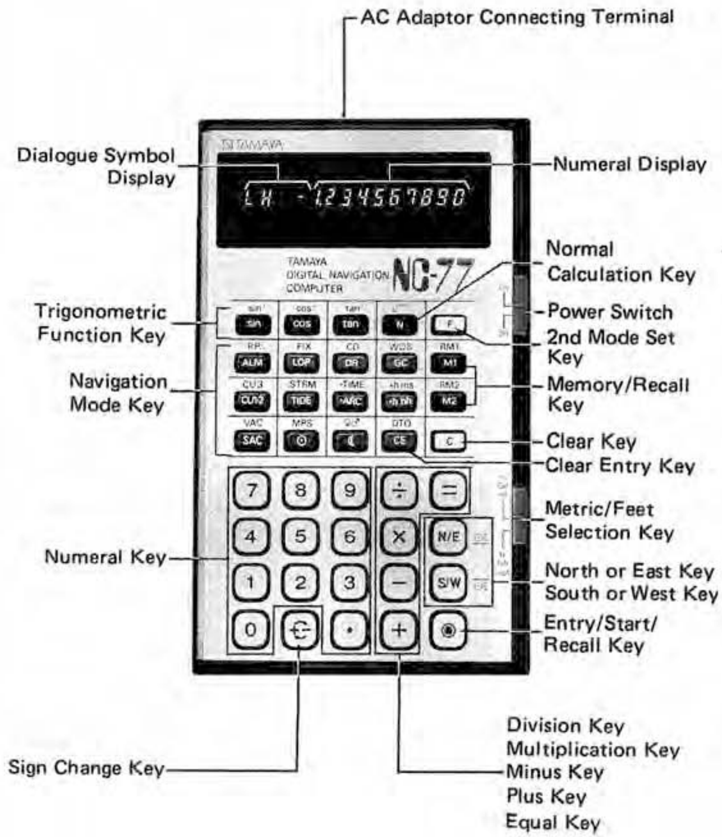
Keep NC-77 away from water, moisture or extreme heat or low temperature. Use the storage case as protection against vibration and shock.

CONTENTS

INTRODUCTION

The new TAMAYA NC-77 DIGITAL NAVIGATION COMPUTER is specifically designed to solve all major navigation problems with its internally built-in programs. The operation is very easy. There are no complicated rules to memorize or programming knowledge to learn to use this handy instrument. Simply follow the dialogue instruction display which tells you at each step what data to feed in. The principle of operation can be learned without extended study by just looking at one example for each problem comprehensively illustrated in this instruction manual.

EXTERNAL FEATURES



MODE SELECTORS AND KEYS

NORMAL CALCULATION MODE KEY

[N] key clears the programmed navigation mode and sets the normal calculation mode.

DUAL FUNCTION KEY

[F] key pressed before each dual function mode key sets the 2nd mode i.e. $\sin^{-1}$, $\cos^{-1}$, $\tan^{-1}$, P.P., FIX, CD, RM1, RM2, etc.

SCIENTIFIC FUNCTION KEYS

[sin] [cos] [tan] : Trigonometric function keys

[$\sin^{-1}$] [$\cos^{-1}$] [$\tan^{-1}$] : Inverse trigonometric function keys

[$\sqrt{\ }$] : Square root computation key

NAVIGATION MODE KEYS

[ALM] mode key computes the GHA ARIES, DEC SUN, GHA SUN and Equation of Time at any moment through the year 1999.

[P.P.] mode key makes the computation of proportional parts. It is applied in pin-pointing the GHA and DEC of the Moon and planets without using the INCREMENTS AND CORRECTIONS table of Nautical Almanac. It is also used as LORAN LOP interpolator.

[LOP] mode key computes the Altitude and the true Azimuth of the Sun, Moon, planets and the navigational stars to obtain a Line of Position in celestial navigation.

[FIX] mode key computes the latitude and longitude of fix by two Lines of Position.

[DR] mode key computes the Dead Reckoning Position by Mercator Sailing or Parallel Sailing.

[CD] mode key computes the Course and Distance by Mercator Sailing or Parallel Sailing.

[GC] mode key computes the Great Circle Distance and the Initial Course. The program continues to compute Latitude and Longitude of the Vertex, and the Latitude at any selected Longitude on the Great Circle track.

[WDS] mode key computes the True Wind Direction and True Wind Speed.

[CU 1] mode key computes the Course and Speed Made Good through a current. This key is also used for the solution of Traverse Sailing.

[CU 2] mode key computes the Course to Steer and the Speed to Use to make good a given course and speed through a current.

[CU 3] mode key computes the Course to Steer at a given speed to make good a given course through a current.

[TIDE] mode key computes the Height of Tide at any selected time.

[STRM] mode key computes the Velocity of Stream (Tidal Current) at any selected time.

[SAC] mode computes the True Altitude by the standard sextant altitude corrections at 10°C, 1013.25mb (50°F, 29.92 in.).

[VAC] mode computes the True Altitude at variable temperature and atmospheric pressure. Both [SAC] and [VAC] compute the True Altitude for the Sun, Moon, planets and the stars.

[☉] [☾] [♀♂] These keys are used in connection with [SAC] and [VAC] to specify the celestial body, the Sun, Moon, Venus or Mars in making the sextant altitude corrections.

$\underline{☉☾}$ $\overline{☉☾}$ In [SAC] and [VAC] mode $\underline{☉☾}$ means the sighting of the lower limb and $\overline{☉☾}$ means the sighting of the upper limb of the Sun or Moon.

[MPS] mode key computes the Latitude and Longitude by noon sight (Sun's meridian passage).

[DTO] mode key computes the Distance to an Object by the vertically measured angle.

[►ARC] key sets the computation in degrees, minutes and 1/10 minute.
This key also converts hours, minutes, seconds into degrees, minutes and 1/10 minute.

[►TIME] key sets the computation in hours, minutes and seconds. This key also converts degrees, minutes, 1/10 minute into hours, minutes and seconds.
(ARC to TIME or TIME to ARC conversion is made by the above two keys.)

[►h.hh] key converts hours, minutes and seconds into hours, 1/10 hour and 1/100 hour.

[►h.ms] key converts hours, 1/10 hour, 1/100 hour into hours, minutes and seconds.
The above two keys are used in Speed, Time and Distance computations.

[N/E] key designates North in latitude and East in longitude.

[S/W] key designates South in latitude and West in longitude.

MEMORY KEYS

[M1] [M2] Memory keys

[RM1] [RM2] Recall memory keys

OTHER KEYS

[C] Clears all the computation registers, error, etc. Resumes the beginning of the program in the navigation programs.

[CE] Clears only displayed register.

[0] – [9] Numeral keys to enter a number.

[•] Designates the decimal point of a set number.

[×] [÷] [+] [–] Sets the order of each function.

[=] Completes the addition, subtraction, multiplication, division functions.

[±] Changes the sign of a displayed number.

[⊙] Enters a number, starts the programmed computation or recalls the programmed memory.

POWER SWITCH

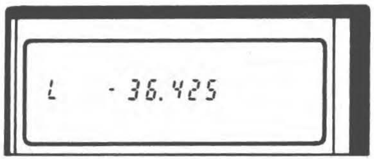
on / off — When the power switch is in "ON" position the computer is powered, automatically cleared and ready for operation in normal calculation mode.

METRIC/FEET SELECTION SWITCH

m. / Cel. / m.b. — ft. / Fah. / inch — In [SAC] and [VAC] mode the switch selects the input by meters, Celsius (temperature) and millibars (pressure), or feet, Fahrenhiet and inches of mercury. In [DTO] mode it selects the input by meters or feet.

DIALOGUE SYMBOLS AND THE MEANING

Dialogue system makes the operation very easy by telling you at each step what data to feed in. The answers are also accompanied by the symbols which specify the meaning.



Ex. Latitude 36°42′ .5S

— sign after L indicates South latitude
— sign after II indicates West longitude
E: overflow error symbol
—: minus symbol

NC-77 DIALOGUE SYMBOLS

CD. DR. GC.

L	Lat.
II	Long.
c	Course
d	Distance
Lu	Vertex Lat.
IIu	Vertex Long.
II'	Selected Long.
L'	Corres. Lat.

LOP

LH	LHA
d	Dec.
L	Lat.
A	Computed Alt.
Ξ	Azimuth

ALM

Y	Year. Month Day
h	Time of Observ.
Ho	GHA ♈ (Aries)
d	Dec. ⊙ (Sun)
H	GHA ⊙ (Sun)
to	Eqn. of Time

P.P.

h	Time (1)
d	Corres. Arc
h	Time (2)
d	Corres. Arc
h'	Selected Time
d'	Corres. Arc

FIX

L	Lat.
II	Long.
d	Intercept
Ξ	Azimuth

MPS

h	Time of Mer. Pass.
Ao	True Alt.
d	Dec.
to	Eqn. of Time
L	Lat.
II	Long.

SAC VAC

A i	Sextant Alt.
h t	Height of Eye
A r	Dip Corrected Alt.
t	Temperature
P	Pressure
A n	Refract. Corrected Alt.
S d	Semidiameter
h P	Horizontal Parallax
A o	True Alt.

TIDE

h	Time of Low
d	Ht. of Low Tide
h	Time of High
d	Ht. of High Tide
h'	Selected Time
d'	Corres. Ht.

STRM

h	(1) Time of Slack
h	(2) Time of Max.
d	Vel. at Max.
h'	Selected Time
d'	Corres. Vel.

DTO

A i	Sextant Alt.
h t	(1) Height of Eye
h t	(2) Height of Object
d	Dist. to Object

▸TIME ▸ARC ▸h.ms

h	Hour. Minute Second
d	Degree. Minute 1/10 Minute

CU1

c	Course to Steer
d	Speed Thru Water
c	Set (Toward)
d	Drift
c	Course Made Good
d	Speed Made Good

CU2

c	Course to Make Good
d	Speed to Make Good
c	Set (Toward)
d	Drift
c	Course to Steer
d	Speed Thru Water

CU3

c	Course to Make Good
d	Speed Thru Water
c	Set (Toward)
d	Drift
c	Course to Steer
d	Speed Made Good

WDS

c	Ship Course
d	Ship Speed
c	Ship Co. ± Appar. W.D. (From)*
d	Appar. Wind Speed
c	True Wind Direction
d	True Wind Speed

*+ Starboard
— Port Side

Speed (Knot) : d [÷] t [▸h.hh] [=]
Time (h. ms) : d [÷] s [=] [▸h.ms]
Distance (n.m.) : s [×] t [▸h.hh] [=]

MEMORY CAPABILITIES

NC-77 has two user-accessible memories, M1 M2 and RM1 RM2, to greatly increase the flexibility of computations. Use of the memory keys does not affect the displayed number or computation in progress, so they can be used at any point in a computation. They can save you key strokes by storing long numbers that are to be used several times.

Key	display
[5] [F] [√]	2.236067977
[M1]	2.236067977
[+] 10 [F] [√] [=]	5.398345637
[F] [RM1]	2.236067977
[×] 4 [=]	8.944271908
[C]	0
[F] [RM1]	2.236067977

Besides M1, M2 and RM1, RM2 two extra memories are provided internally for the output of ALM, FIX, LOP, CD, DR, WDS, CU1, 2, 3, and MPS, where there are two answers to be recalled alternatively.

NOTE ON DECIMAL POINT

In NC-77 TIME is always expressed as Hours, Minutes, Seconds, and ARC as Degrees, Minutes, 1/10 minute to follow conventional navigation practice. The decimal point should be entered as follows. The same rule applies to the reading of the displayed outputs.

TIME	12^h	15^m	33^s	Enter	12.1533
		15	33		.1533
		5	33		.0533
			33		.0033
			3		.0003

ARC	180°25:5	Enter	180.255
	25:5		.255
	5:5		.055
	0:5		.005

Input/output of trigonometric and inverse trigonometric computation follows the same rule as ARC.

0.8 [F] [sin⁻¹] → 53.078 is read as 53°07:8

In ALM (Almanac) mode the year, month and day are entered as follows.

ALM	January 2nd, 1978	Enter	78.0102
	12^h 06^m 08^s		12.0608

BASIC NAVIGATION PROGRAMS FOR DEAD RECKONING AND PILOTING

I MERCATOR SAILING AND GREAT CIRCLE SAILING

1. Dead Reckoning by Mercator Sailing

[DR] Dead Reckoning mode computes the latitude and longitude of the point of arrival.

Problem 1		Key	Display	Answer	
Departure Point Lat.	32°30:6N	[DR]	L 0.	D.R. Lat.	30°34:2N
Departure Point Long.	118°36:2W	32.306 [N/E]	L 32.306	D.R. Long.	123°34:6W
Course	245°30′	[⊙]	// 0.		
Distance	280.8 miles	118.362 [S/W]	// – 118.362		
		[⊙]	c 0.		
		245.3	c 245.3		
		[⊙]	d 0.		
		280.8	d 280.8		
		[⊙]	L 30.342		
		[⊙]	// – 123.346		
		[⊙]	Repeat L and //		

2. Course and Distance by Mercator Sailing

[CD] Course and Distance mode computes the course and distance from the departure point to the arrival point.

Problem 2		Key	Display	Answer
Departure Point Lat.	35°22:4N	[F] [CD]	L 0.	Course made good 203°40′.5
Departure Point Long.	125°08:2W	35.224 [N/E]	L 35.224	Distance 3480.5 n.m.
Arrival Point Lat.	17°45:2S	[⊙]	// 0.	
Arrival Point Long.	149°30:0W	125.082 [S/W]	// – 125.082	
		[⊙]	L 0.	
		17.452 [S/W]	L – 17.452	
		[⊙]	// 0.	
		149.30 [S/W]	// – 149.30	
		[⊙]	c 203.405	
		[⊙]	d 3480.5	
		[⊙]	Repeat c and d	

Note on Accuracy: The principle of [DR] and [CD] computation is Mercator Sailing. The oblate spheroid characteristics of earth (flattened at the poles and bulged at the equator) is taken into consideration in the programming. The most up-to-date WGS-72, World Geodetic System 1972 spheroid (Eccentricity = 0.08182), is being used to guarantee the utmost accuracy. When the course is exactly 090° or 270° the program automatically switches to Parallel Sailing. In this case the earth is considered as a sphere.

3. Great Circle Sailing

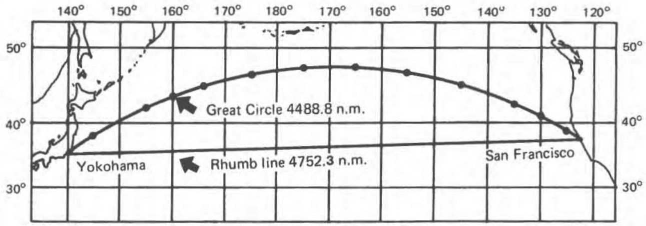
[GC] Great Circle Sailing mode computes the great circle distance between two points and also the initial course from the departure point. The program continues to compute the latitude and longitude of the vertex, and the latitude at any selected longitude on the great circle track.

Problem 3		Key	Display	Answer
Departure Point Lat.	37°50.'8N	[GC]	L 0.	Great circle distance
Departure point Long.	122°25.'5W	37.508 [N/E]	L 37.508	4488.8 n.m.
	(San Francisco)	[⊙]	// 0.	
Arrival point Lat.	34°52.'0N	122.255 [S/W]	// – 122.255	Initial great circle course
Arrival Point Long.	139°42.'0E	[⊙]	L 0.	302°37.'9
	(Yokohama)	34.520 [N/E]	L 34.520	Vertex Lat. 48°19.'0N
		[⊙]	// 0.	Vertex Long. 168°38.'8W
		139.420 [N/E]	// 139.420	Latitude at
		[⊙]	d 4488.8	145°W 45°48.'7N
		[⊙]	c 302.379	150°W 46°46.'7N
		[⊙]	Lv 48.190	
		[⊙]	//v – 168.388	
		[⊙]	//' 0.	
		145 [S/W]	//' – 145.	
		[⊙]	L' 45.487	
		[⊙]	//' 0.	
		150 [S/W]	//' – 150.	
		[⊙]	L' 46.467	
		⋮	Continue	

Note: In computing the great circle distance the earth is considered as a sphere. The vertex is computed between the departure and the arrival point. If there is no vertex to be found between them the next vertex on the same great circle track beyond the arrival point is computed.

Mercator Sailing and Great Circle Sailing:

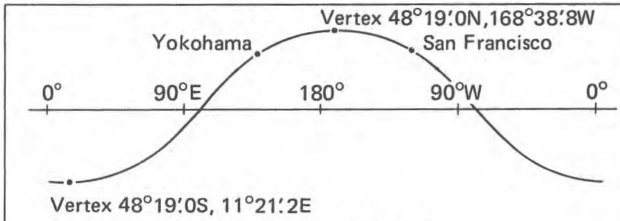
The course obtained by Mercator Sailing is a rhumb line, appearing as a straight line on the Mercator chart. It makes the same angle with all meridians it crosses, and maintains constant true direction. The Great Circle track is the shortest distance between any two points on the earth. On the Mercator chart a great circle appears as a sine curve extending equal distances each side of the equator. The comparison of rhumb line and great circle track is shown in the illustration.



MERCATOR CHART

Vertex:

Every great circle lies half in the northern hemisphere and half in the southern hemisphere. Any two points 180° apart on a great circle have the same latitude numerically, but contrary names, and are 180° apart in longitude. The point of greatest latitude is called the vertex.



Great Circle and Vertex

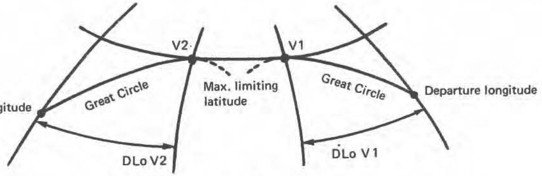
Point to point planning:

Since a great circle is continuously changing direction as one proceeds along it, no attempt is customarily made to follow it exactly. Rather, a number of points are selected along the great circle, and rhumb lines are followed from point to point, taking advantage of the fact that for short distances a great circle and a rhumb line almost coincide. These points are selected every 5° of longitude for convenience (the number of points to use is a matter of personal preference), and the corresponding latitudes are computed by NC-77 as in problem 3.

Composite Sailing:

When the great circle would carry a vessel to a higher latitude than desired, a modification of great circle sailing called composite sailing, may be used to good advantage. The composite track consists of a great circle from the point of departure and tangent to the limiting parallel, a course line along the parallel, and a great circle tangent to the limiting parallel and through the destination. If such a course is desired, it can be computed by NC-77 with the equations and key sequence shown in the example below.

Problem: Between San Francisco, 37°50.'8N, 122°25.'5W and Yokohama 34°52.'0N, 139°42.'0E, find the composite track with the maximum limiting latitude of 45°N.



Composite Sailing

Equations:

$$\mathrm{DLov}_1 = \cos^{-1}\left(\frac{\tan L_1}{\tan L_{max}}\right) \qquad \mathrm{DLov}_2 = \cos^{-1}\left(\frac{\tan L_2}{\tan L_{max}}\right)$$

Key sequence:

DLov1; [N] 37.508 [tan] [÷] 45 [tan] [=] [F] [cos^{-1}] → 39.009

DLov2; [N] 34.520 [tan] [÷] 45 [tan] [=] [F] [cos^{-1}] → 45.500

Answer: V1: The longitude at which the limiting parallel is reached is 39°00.'9 west of the departure point, which is 161°26.'4W.

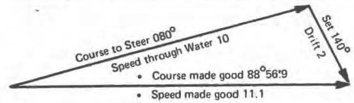
V2: The longitude at which the limiting parallel should be left is 45°50.'0 east of the arrival point, which is 174°28.'0W.

II PLANE SAILING AND NAVIGATION THROUGH CURRENT AND WIND

1. Finding the Course and Speed Made Good through a current

[CU 1] Current 1 mode computes the course made good and speed made good when the course to steer and speed through water are given, and set and drift are known.

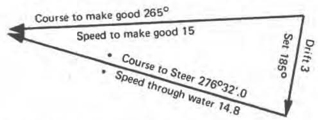
Problem 1	Key	Display	Answer
Course to Steer 080°	[CU1·2]	c 0.	Course Made Good 88°56.'9
Speed through Water	80	c 80.	Speed Made Good 11.1 knots
10 knots	[◎]	d 0.	
Set (toward) 140°	10	d 10.	
Drift 2 knots	[◎]	c 0.	
	140	c 140.	
	[◎]	d 0.	
	2	d 2.	
	[◎]	c 88.569	
	[◎]	d 11.1	
	[◎]	Repeat c and d	



2. Finding the Course to steer and Speed to use (through water) to make good a given course and speed through a current.

[CU 2] Current 2 mode computes the course to steer and speed through water when the course to make good and speed to make good are given, and set and drift are known. [CU 1] and [CU 2] programs are common, but the drift is entered with the reversed sign in the latter.

Problem 2	Key	Display	Answer
Course to Make Good 265°	[CU1·2]	c 0.	Course to Steer 276°32.'0
Speed to Make Good	265	c 265.	Speed through Water 14.8 knots
15 knots	[◎]	d 0.	
Set (toward) 185°	15	d 15.	
Drift *1 3 knots	[◎]	c 0.	
	185	c 185.	
	[◎]	d 0.	
	3 [±]	d −3.	
	[◎]	c 276.320	
	[◎]	d 14.8	
	[◎]	Repeat c and d	

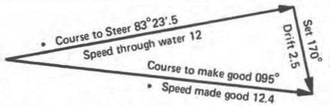


*1. Always reverse the sign of "drift" input in solving the [CU 2] problem.

3. Finding the Course to steer at a given speed to make good a given course through a current

[CU 3] Current 3 mode computes the course to steer and speed made good when the course to make good and speed through water are given, and set and drift are known.

Problem 3	Key	Display	Answer
Course to Make Good 095°	[F] [CU 3]	c 0.	Course to Steer 83°23′.5
Speed through Water 12 knots	95	c 95.	Speed Made Good 12.4 knots
Set (toward) 170°	⊙	d 0.	
Drift 2.5 knots	12	d 12.	
	⊙	c 0.	
	170	c 170.	
	⊙	d 0.	
	2.5	d 2.5	
	⊙	c 83.235	
	⊙	d 12.4	
	⊙	Repeat c and d	



Note: The desired course (course to make good) cannot be made when ship's speed is not sufficient to overcome the drift. In such a case the output becomes E.

4. Traverse Sailing

[CU 1] Current 1 mode is also used for the solution of Traverse Sailing. A traverse is a series of courses, or a track consisting of a number of course lines, as might result from a sailing vessel beating into the wind. Traverse Sailing is the finding of a single equivalent course and distance.

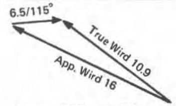
Problem 4		Key	Display	Answer
Course	Distance	[CU1·2]	c 0.	Single Equivalent Course and Distance
		158	c 158.	161°29′.7
158°	15.5	⊙	d 0.	43.5 n.m.
135°	33.7	15.5	d 15.5	
259°	16.1	⊙	c 0.	15.5/158°
		135	c 135.	
		⊙	d 0.	
		33.7	d 33.7	
		⊙	c 142.118	33.7/135°
		⊙	d 48.3	
		[M1]	d 48.3	
		⊙	c 142.118	
		[CU1·2]	c 142.118	
		⊙	d 0.	16.1/259°
		[F] [RM1]	d 48.3	
		⊙	c 0.	
		259	c 259.	
		⊙	d 0.	
		16.1	d 16.1	
		⊙	c 161.297	
		⊙	d 43.5	

More courses may be added by repeating the same process.

5. Finding the Direction and Speed of True Wind

[WDS] Wind Direction and Speed mode computes the True Wind Direction and True Wind Speed when a ship is taking a certain course at a certain speed.

Problem 5	Key	Display	Answer
Ship Course 115°	[F] [WDS]	c 0.	True Wind Direction 162°24′.0
Ship Speed 6.5 knots	115	c 115.	True Wind Speed 10.9 knots
Apparent Wind Direction	⊙	d 0.	
30° starboard	6.5	d 6.5	
Apparent Wind Speed	⊙	c 0.	
16 knots	115 [+] 30 [=]	c 145.000 *2	
	⊙	d 0.	
	16	d 16.	
	⊙	c 162.240	
	⊙	d 10.9	
	⊙	Repeat c and d	



*2. Ship course ± Apparent Wind Direction should be entered here. Use (+) when the apparent wind is blowing from starboard and (−) for port side.

Note: NC-77 solves the current and wind problems by Plane Sailing.

III. TIDE AND STREAM (TIDAL CURRENT)

1. Finding the Height of Tide

[TIDE] Tide mode computes the height of tide at any selected time.

Problem 1	Key	Display	Answer
Time of Low Tide 01^h45^m	[TIDE]	h 0.	Height of Tide at 07^h35^m 10.8ft
Height of Low Tide 0.6ft.	1.45	h 1.45	
Time of High Tide 09^h06^m	⊙	d 0.	
Height of High Tide 11.9ft.	0.6	d 0.6	
Selected Time 07^h35^m	⊙	h 0.	
	9.06	h 9.06	
(Seattle, Wash. Dec. 1, 1977)	⊙	d 0.	
	11.9	d 11.9	
	⊙	h' 0.	
	7.35	h' 7.35	
	⊙	d' 10.8	
	⊙	h' 0.	
	⋮	Continue	

2. Finding the Velocity of Stream (Tidal Current)

[STRM] Stream Mode computes the velocity of stream (tidal current) at any selected time.

Problem 2	Key	Display	Answer
Time of Slack 01^h42^m	[F] [STRM]	h 0.	Velocity at 03^h30^m
Time of Max. 04^h43^m	1.42	h 1.42	3.7 knots toward 245°T
Velocity at Max. 4.6 knots	[⊙]	h 0.	
245°T	4.43	h 4.43	
Selected Time 03^h30^m *1	[⊙]	d 0.	
	4.6	d 4.6	
(San Francisco Bay Entrance	[⊙]	h' 0.	
Aug 16, 1977)	3.3	h' 3.3	
	[⊙]	d' 3.7	
	[⊙]	h' 0.	
	⋮	Continue	

*1. If the selected time is between the Max. and Slack time, for example Max 5^h00^m, Slack 10^h00^m and the selected time 8^h00^m, input 10^h00^m first, and then 5^h00^m and its velocity. Then enter 8^h00^m to obtain the corresponding stream.

Note: The local information on TIDE and STREAM is given in TIDE TABLES and TIDAL CURRENT TABLES by the U.S. Department of Commerce or the equivalent authorities of the other countries.

IV SPEED, TIME, DISTANCE

Speed, Time and Distance are computed by the following key sequence, selecting [N] mode in the beginning

Speed (Knots)	:	d [÷] t [▸h.hh] [=]
Time (h.ms)	:	d [÷] s [=] [F] [▸h.ms]
distance (n.m.)	:	s [×] t [▸h.hh] [=]

Problem 1. A ship travels 35.2 nautical miles in 1 hour and 35 minutes.
What is the ship speed?
35.2 [÷] 1.35 [▸h.hh] [=] Answer: 22.2 knots

Problem 2. How long will it take to travel 125 nautical miles at ship speed of 21.5 knots?
125 [÷] 21.5 [=] [F] [▸h.ms] Answer: $5^h48^m50^s$

Problem 3. A ship travels at a speed of 18.3 knots for 5 hours and 45 minutes.
What is the distance traveled?
18.3 [×] 5.45 [▸h.hh] [=] Answer: 105.2 n.m.

V TIME AND ARC

TIME and ARC Computations

Time mode makes hours, minutes, seconds computation; ARC mode makes degrees, minutes, and 1/10 minute computation. TAMAYA NC-77 follows the customary navigation rule of expressing seconds in terms of 1/10 of a minute in arc mode.

Problem 1	Key	Display	Problem 2	Key	Display
$(14^h59^m23^s$	[C] [F] [▸TIME]	h 0.0000	(38°29.'8	[C] [▸ARC]	d 0.000
$+ 15^h01^m59^s)$	14.5923	h 14.5923	+ 39°48.'8)	38.298	d 38.298
$\div 2 = 15^h00^m41^s$	[+]	h 14.5923	÷ 2 = 39°09.'3	[+]	d 38.298
	15.0159	h 15.0159		39.488	d 39.488
	[÷]	h 30.0122		[÷]	d 78.186
	2	h 2.		2	d 2.
	[=]	h 15.0041		[=]	d 39.093

ARC ⇄ TIME Conversion

- ▶ ARC mode converts hours, minutes, and seconds into degrees, minutes and 1/10 minute.
- ▶ TIME mode converts degrees, minutes, and 1/10 minute into hours, minutes and seconds.

Problem 3	Key	Display
Arc 35°41.'8		
↓	35.418	35.418
$2^h22^m47^s$	[F] [▸TIME]	h 2.2247

Problem 3 (b)	Key	Display
Time $3^h\ 51^m\ 03^s$		
↓	3.5103	3.5103
57°45.'7	[▸ARC]	d 57.457

CELESTIAL NAVIGATION PROGRAMS

I NAUTICAL ALMANAC (GHA ARIES, DEC SUN, GHA SUN, Eqn. of Time)

[ALM] Almanac mode computes the GHA ARIES, DECLINATION SUN, GHA SUN, and EQUATION OF TIME at any given time of the year through the year 1999.

Problem 1. Find the GHA ARIES, GHA SUN, DEC SUN and Eqn. of Time at GMT $15^h07^m03^s$ on the 2nd. of January 1978.

Key	Display	Answer
[ALM]	y 0.	
78.0102	y 78.0102	
[⊙]	h 0.	
15.0703	h 15.0703	
[⊙]	Ho 328.396	GHA ARIES 328° 39′.6 *1
[⊙]	d −22.546	DEC SUN S22° 54′.6
[⊙]	H 45.453	GHA SUN 45° 45′.3
[⊙]	to −0.0402	Eqn. of Time -4^m02^s
[⊙]	Repeat d and H	

*1 GHA ARIES, DEC SUN and GHA SUN are used as entry data to obtain Line of Position in LOP mode. EQUATION OF TIME is used in MPS mode to find the Latitude and Longitude by observation of the Sun's highest altitude (Meridian Passage).

Note 1.
Accuracy: This program has been checked against the master program of the Hydrographic Institute of Japan from Jan. 1, 1977 to Dec. 31, 1999. The sporadic deviation found at any moment during this period is within ±0′.3 at the maximum for the GHA's, DEC and Eqn. of Time. Virtually, in most cases the deviation is nil or within ±0′.1 and the answers accordingly agree with the figures found in the Nautical Almanac.

Note 2.
Validity: The year is entered as 77,78 .... 98,99 until 1999. January 2000 is entered as the thirteenth(13) month of the year 1999. In this manner, practically, the Almanac can be automatically computed by NC-77 until February 29, 2000 (14th month of 1999). After this date the leap year and the number of days in each month must be taken into consideration when entering the day and month.

II PROPORTIONAL PARTS (Interpolator)

[P.P.] Proportional Parts is used to find the exact GHA and DEC of a celestial body without using the INCREMENTS AND CORRECTIONS pages of the Nautical Almanac. It may be used as an interpolator in finding a LORAN LOP, or for other general purposes.

Problem 1. Find the GHA and DEC of Venus at GMT $10^h57^m\ 28^s$ on May 6, 1978 when the following information is found in the Nautical Almanac.

VENUS			GHA		DEC	
GMT			Key	Display	Key	Display
	GHA	DEC	[F] [P.P.]	h 0.	[F] [P.P.]	h 0.
10	304°32′.7	22°57′.7	10	h 10.	10	h 10.
11	319 31.9	22 58.3	[⊙]	d 0.	[⊙]	d 0.
			304.327	d 304.327	22.577	d 22.577
			[⊙]	h 0.	[⊙]	h 0.
			11	h 11.	11	h 11.
			[⊙]	d 0.	[⊙]	d 0.
			319.319	d 319.319	22.583	d 22.583
			[⊙]	h′ 0.	[⊙]	h′ 0.
			10.5728	h′ 10.5728	10.5728	h′ 10.5728
			[⊙]	d′ 318.539	[⊙]	d′ 22.583
			[⊙]	h′ 0.	[⊙]	h′ 0.
			⋮	Continue		Continue

Answer GHA 318° 53′.9
DEC 22° 58′.3

This interpolator may be used in the same manner for the Sun, Moon, planets and Aries.

III LINE OF POSITION AND IDENTIFICATION OF UNKNOWN STAR (Altitude and Azimuth)

[LOP] Line of Position mode computes the altitude and the true azimuth of a celestial body. These factors are used to plot a Line of Position.

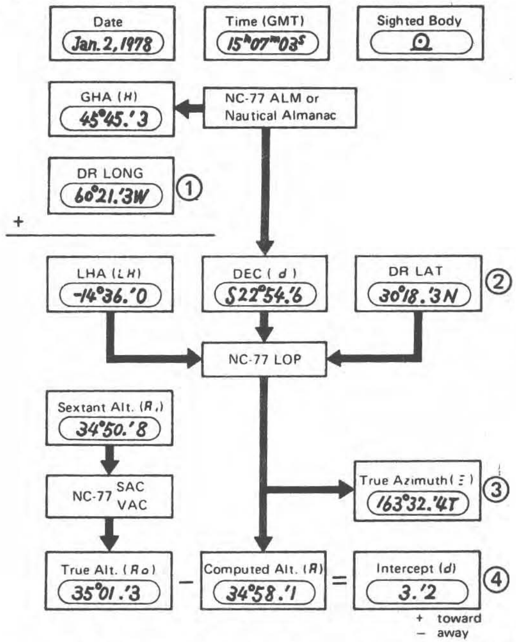
Problem 1	Key	Display	Answer
Greenwich Hour Angle (GHA)	[LOP]	LH 0.	Computed altitude of the Sun
of the Sun 45°45′.3	45.453	LH 45.453	(Hc) 34°58′.1
	[+] 60.213 [S/W]	LH −60.213	
	[=]	LH −14.360 *1	
Declination of the Sun	[⊙]	d 0.	
S22°54′.6	22.546 [S/W]	d −22.546	Azimuth of the Sun
DR Latitude of the ship	[⊙]	L 0.	(Zn) 163°32′.4T
30°18′.3N	30.183 [N/E]	L 30.183	
	[⊙]	A 34.581	
DR Longitude of the ship	[⊙]	Z 163.324	
60°21′.3W	[⊙]	Repeat A and Z	

Note 1. GHA and LHA:
When continuing directly to LOP mode from ALM mode do not confuse H and LH. H stands for Greenwich Hour Angle (GHA) and LH for Local Hour Angle (LHA). LHA = GHA ± DR Longitude. This computation may be made in either, ALM or LOP mode, but the dialogue symbol does not change from H to LH until LOP mode key is pressed. See NC-77 LOP COMPUTATION CHART. (TABLE 2).

Note 2. GHA and DEC Data Source:
Sun's GHA and DEC are computed by NC-77, or found in the Nautical Almanac.
Star's GHA is obtained by adding GHA Aries and SHA of the star (GHA star = GHA Aries + SHA of the star).
In this case GHA Aries is computed by NC-77 or found in the Nautical Almanac, but SHA star must be found in the Nautical Almanac. Star's DEC is also found in the Nautical Almanac.
GHA and DEC of Moon and planets are found in the Nautical Almanac.

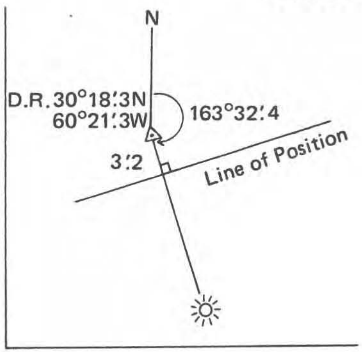
*1 Some navigators are accustomed to expressing LHA always as a positive value by applying 360°: LHA = 360° − 14°36.'1 = 345°23.'9
In such a case you may enter LHA 345°23.'9 instead of −14°36.'1. The end result is the same.

NC-77 LOP COMPUTATION CHART



Plot Line of Position or Compute Fix by NC-77 with data ①②③④

TABLE 2



Using the data ① ② ③ ④ in TABLE 2 a Line of Position is plotted on a chart.

Identification of Unknown Star

If we know the altitude and bearing of a star, and want to find out what star it is, [LOP] mode is used in the following manner.

Problem 2: At GMT$19^h32^m16^s$ on Jan. 1, 1978 an unknown star is observed at altitude 62°36′.3 and approximate azimuth 72°T. The ship's DR position is 12°40′N 152°22′E

Required: Indentity of the star.

Key	Display	
[LOP]	LH 0.	
72	LH 72.	
[⊙]	d 0.	
62.363	d 62.363	
[⊙]	L 0.	
12.40 [N/E]	L 12.40	
[⊙]	A 19.286	.... Approximate declination
[⊙]	Ξ 332.206	.... Approximate local hour angle

Then compute the following in ARC mode.

Local hour angle of star (LHA)	332°20′.6	
Subtract DR longitude of ship	−152 22.0E	*1
Greenwich hour angle of star (GHA)	179 58.6	
Subtract GHA Aries for $19^h32^m16^s$ (GHA) Jan. 1, 1978	− 34 09.6	
Sidereal hour angle of star (SHA)	145 49.0	*2

Entering STAR table on Pages 268-273 of the Nautical Almanac with SHA 145°49′.0 and DEC N19°28′.6, the star with the closest values is found to be α Bootis (SHA 146°20′.2 DEC N19°17′.7), another name of which is Arcturus, star No. 37. In the event that a reasonably close match of the computed SHA and DEC values cannot be found in the STARS table, it is possible that the body observed was actually a planet, and the SHA values of the four navigational planets at the bottom of the STARS table of the daily pages also should be checked.

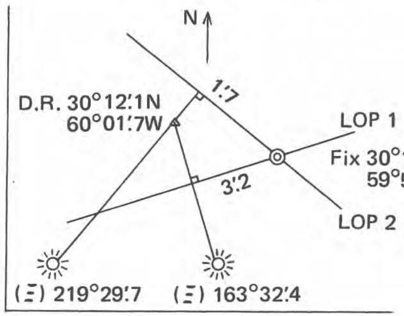
*1 Add if longitude is west.
*2 If the answer becomes negative, add 360° to get SHA
If the answer is greater than 360°, subtract 360°

IV FIX BY TWO LOP's

[FIX] Fix mode computes the latitude and longitude of the fix obtained by two Lines of Position.

Problem 1	Key	Display	Answer
DR Lat. 30°12′.1N	[F] [FIX]	L 0.	
Long. 60°01′.7W	30.121 [N/E]	L 30.121	
LOP1 Intercept 3.2 Toward	[⊙]	H 0.	
Azimuth 163°32′.4	60.017 [S/W]	H −60.017	
LOP2 Intercept 1′.7 Away	[⊙]	d 0.	
Azimuth 219°29′.7	3.2	d 3.2	
	[⊙]	Ξ 0.	
	163.324	Ξ 163.324	
	[⊙]	d 0.	
	1.7 [CHS]	d −1.7 *1	
	[⊙]	Ξ 0.	
	219.297	Ξ 219.297	
	[⊙]	L 30.102	Fix Lat. 30°10′.2N
	[⊙]	H −59.560	Long. 59°56′.0W
	[⊙]	Repeat L and H	

*1 Intercept is entered as (—) if it is away, (+) if toward.



For running fix use the Intercept and Azimuth of LOP1 and LOP2 in combination with the DR of the latter.
In this example D.R. position has been moved along the ship course, 18 miles on course 110°, from 30°18′.3N, 60°21′.3W, which is used in TABLE 2.

V LATITUDE AND LONGITUDE BY SUN'S MERIDIAN ALTITUDE (MERIDIAN PASSAGE)

[MPS] Meridian Passage mode computes the latitude and longitude of the ship at the moment when the sun has reached its highest point (the meridian passage).

Problem 1	Key	Display	Answer
Time of Sun's meridian pass.			
GMT21h39m35s, Oct. 25, 1978	[F] [MPS]	h 0.	
True Meridian Altitude 49°43.'9 Bearing South	21.3935	h 21.3935	
DEC SUN S12°12.'6	[⊙]	Ao 0.	
Eqn. of Time 0h15m55s	49.439 [S/W]	*1 Ao –49.439	
	[⊙]	d 0.	
	12.126 [S/W]	d –12.126	
	[⊙]	to 0.	
	0.1555	to 0.1555	
	[⊙]	L 28.035	Lat. 28°03.'5N
	[⊙]	ll –148.525	Long. 148°52.'5W
	[⊙]	Repeat L and ll	

*1 Whether the Meridian Altitude is sighted bearing South [S/W] or North [N/E] should be keyed as in the above example.

Note: Meridian altitude is observed by a Marine sextant. Sextant altitude correction by [SAC] or [VAC] mode should be applied to the direct sextant reading to obtain the true meridian altitude. Time of meridian passage can best be determined by plotting on cross-section paper a series of observed altitudes versus times (GMT) of observations, commencing several minutes before estimated local apparent noon (based on the DR longitude) and continuing until several minutes after meridian passage. From a curve faired through the plotted points, the time of maximum altitude can be established. DEC Sun and Eqn. of Time are derived by NC-77 [ALM] mode or taken from the Nautical Almanac.

VI STANDARD SEXTANT ALTITUDE CORRECTIONS

[SAC] mode computes the True Altitude by Standard Sextant Altitude Correction at 10°C, 1013.25mb. (50°F, 29.92 in.).

Problem 1. Standard Altitude Corrections: Sun

Problem 1	Key	Display	Answer
SUN ⊙			
Sextant Altitude (lower limb) 34°50.'8	[SAC]	A, 0.	
	34.508	A, 34.508	
Height of Eye 6.5 meter (21.3ft)	[⊙]	ht 0.	
S.D. 16.'3 (Jan.2, 1978)	6.5 *1	ht 6.5	
	[⊙]	Ar 34.463	Dip corrected alt. 34°46.'3
	[⊙]	An 34.449	Refraction corrected alt. 34°44.'9
	[⊙]	Sd 0.	
	0.163 ⊙☾	Sd 0.163	
	[⊙]	Ao 35.013	True altitude 35°01.'3

* Make sure whether computation is made in Meters or Feet.

Problem 2. Standard Altitude Corrections: Moon

Problem 2	Key	Display	Answer
Moon ☾			
Sextant Altitude (upper limb) 18°46.'5	[SAC]	A, 0.	
	18.465	A, 18.465	
Height of Eye 6.5 meter (21.3ft)	[⊙]	ht 0.	
H.P. 58.'9 (Jan. 25, 1978)	6.5	ht 6.5	
	[⊙]	Ar 18.420	
	[⊙]	An 18.391	
	[☾]	hP 0.	
	0.589 ⊙☾	hP –0.589	
	[⊙]	Ao 19.189	True altitude 19°18.'9

Sun and Moon: Select meters or feet by the side selector switch. Choose upper or lower limb by ⊙☾ or ⊙☾ key depending on which side was sighted. The Sun's S.D. and Moon's H.P. are given in the Nautical Almanac (The summerized data of Sun's S.D. for 1978 are given in TABLE 1 on the inside of the front cover of this booklet. Moon's H.P. at every hour of the day is found in the Nautical Almanac). If S.D. or H.P. is entered with a wrong decimal point position, for instance, 16.3 instead of 0.163 in the above case, the program blocks it and asks the re-entry of the correct information without having to go back to the very beginning.

Problem 3. Standard Altitude Corrections: Planets

Problem 3	Key	Display	Answer
VENUS ♀	[SAC]	A, 0.	
Sextant Altitude 34°20.'5	34.205	A, 34.205	
Height of Eye 6.5 meters (21.3ft)	[⊙]	ht 0.	
H.P. 0.'3 (Sep. 15, 1978)	6.5	ht 6.5	
	[⊙]	Ar 34.160	
	[⊙]	An 34.146	
	[F] [♀♂]	hP 0.	
	0.003	hP 0.003	
	[⊙]	Ao 34.148	True altitude 34°14.'8

H.P. (Horizontal Parallax) applies only to Venus ♀ and Mars ♂ (See TABLE 1 for H.P. data). There is no H.P. for the other navigational planets, Jupiter and Saturn. Altitude corrections for these two planets are, therefore, made as for the stars, which have no H.P.

Problem 4. Standard Altitude Corrections: Stars

Problem 4	Key	Display	Answer
ARCTURUS			
Sextant Altitude 58°27.'9	[SAC]	A, 0.	
Height of Eye 6.5 meters (21.3ft.)	58.279	A, 58.279	
	[⊙]	ht 0.	
	6.5	ht 6.5	
	[⊙]	Ar 58.234	
	[⊙]	An 58.228	True altitude 58°22.'8

Since there is no H.P. for the stars, the refraction corrected altitude An is the true altitude.

[SAC] SUMMARY

Sun ⊙ ⊙̄		Moon ☾ ☾̄		Venus, Mars		Jupiter, Saturn, Stars	
Key	Display	Key	Display	Key	Display	Key	Display
[SAC]	A,						
Sextant Alt.	A,						
[⊙]	ht						
Height of Eye	ht	------SAME AS SUN------					
[⊙]	Ar						
[⊙]	An						
[⊙]	Sd	[☾]	hP		hP		
S.D. (TABLE 1) ⊙☾ or ⊙̄☾̄	Sd	H.P. (Almanac) ⊙☾ or ⊙̄☾̄	hP	H.P. (TABLE 1)	hP		
[⊙]	Ao	[⊙]	Ao	[⊙]	Ao		

A, Sextant Altitude
Ar Dip Corrected
An Refraction Corrected
Ao True Altitude
ht Height of eye
Sd Sun's Semidiameter
hP Horizontal Parallax of Moon, Venus or Mars

VII VARIABLE SEXTANT ALTITUDE CORRECTIONS

[VAC] mode computes the True Altitude by Variable Sextant Altitude Corrections when the use of varying temperature and atmospheric pressure is desired.

Problem 1	Key	Display	Answer
Sextant Altitude (Sun's upper limb) 5°20.'2	[F] [VAC]	A, 0.	
Height of Eye 6.5 meters (21.3ft.)	5.202	A, 5.202	
Temperature −3°C (26.6°F)	[⊙]	ht 0.	
Pressure 986mb (29.12 in.)	6.5	ht 6.5	
S.D. 16.'2	[⊙]	Ar 5.157	Dip corrected alt. 5°15.'7
	[⊙]	t 0.	
	3 [±]	t −3.	
	[⊙]	P 0.	
	986	P 986.	
	[⊙]	An 5.059	Refraction corrected alt. 5°05.'9
	[⊙]	Sd 0.	
	0.162 ⊙̄☾̄	Sd −0.162	
	[⊙]	Ao 4.499	True alt. 4°49.'9

The key sequence for VAC until Refraction Correction is uniform for all Sun, Moon, planets and stars.

In the case of Jupiter, Saturn and Stars An equals the True Altitude since there is no Horizontal Parallax or Semidiameter to be taken into consideration.

Accuracy: Correction for dip = −1.'776 $\sqrt{\text{height of eye in meters}}$ = −0.'98 $\sqrt{\text{height of eye in feet}}$ is used based on F.W. Bessel's terrestrial refraction theory.
For astronomical refraction R. Radau's mean refraction table is simulated by the program. There is no significant difference in accuracy between the various refraction theories.
Irradiation factor is not considered in the program.

VIII DISTANCE TO OBJECT

[DTO] Distance to Object mode computes the Distance to an object when the vertical angle was measured by sextant.

Problem 1	Key	Display	Answer
Sextant Altitude 0°35.'2	[F] [DTO]	A, 0.	
Height of Eye 15 meters (49.2 ft.)	0.352	A, 0.352	
Height of Object 1000 meters (3281 ft.)	[⊙]	ht 0.	
	15	ht 15.	
	[⊙]	ht 0.	
	1000	ht 1000.	
	[⊙]	d 40.3	40.3 n.m.

Select meters or feet by the selector switch before entering the data. The answer is always given in nautical miles.

NORMAL CALCULATIONS (N-MODE)

1 four rules of arithmetic calculation

Problem 1	Key	Display	Note
123 − 45.6 + 789 =	[N] 123 [−]	123.	
	45.6 [+]	77.4	123 − 45.6
	789 [=]	866.4	answer
365 x (−1.15) ÷ 0.5 =	[N] 365 [x]	365.	
	1.15 [±] [÷]	−419.75	365 x (−1.15)
	.5 [=]	−839.5	answer

To enter negative number, depress the [±] key after the number.

2 constant calculation

Problem 2		Key	Display	Note
constant addition	5 + 3 =	[N] 5 [+] 3 [=]	8.	
	10 + 3 =	10 [=]	13.	10 + 3
	15 + 3 =	15 [=]	18.	15 + 3
constant subtraction	5 − 3 =	[N] 5 [−] 3 [=]	2.	
	10 − 3 =	10 [=]	7.	10 − 3
	15 − 3 =	15 [=]	12.	15 − 3
constant multiplication	295 x 8 =	[N] 295 [x] 8 [=]	2360.	
	295 x 6 =	6 [=]	1770.	295 x 6
	295 x (−12) =	12 [±] [=]	−3540.	295 x (−12)
constant division (divisors will be constant)	32 ÷ 2 =	[N] 32 [÷] 2 [=]	16.	
	24 ÷ 2 =	24 [=]	12.	24 ÷ 2
	(−16) ÷ 2 =	16 [±] [=]	−8.	(−16) ÷ 2

3 chain multiplication and division

Problem 3	Key	Display	Note
5 x 3 ÷ 9 =	[N] 5 [x]	5.	
	3 [÷]	15.	5 x 3
	9 [=]	1.666666666	answer

4 square and power calculation

Problem 4	Key	Display	Note
$((2^3)^2)^2 = 2^{12} =$	[N] 2 [x] [=]	4.	2^2
	[=]	8.	2^3
	[x] [=]	64.	$(2^3)^2 = 2^6$
	[x] [=]	4096.	$(2^6)^2 = 2^{12}$

5 reciprocal calculation

Problem 5	Key	Display	Note
$\frac{1}{5} =$	[N] 5 [÷]	5.	
	[=]	1.	
	[=]	0.2	$\frac{1}{5}$

6 mixed calculation

Problem 6	Key	Display	Note
$\left\{\frac{(5+12)\times 18\div 3-16}{4}\right\}^2 =$	[N] 5 [+] 12 [x]	17.	5 + 2
	18 [÷] 3 [−]	102.	(5 + 12) x 18 ÷ 3
	16 [÷] 4 [x]	21.5	$\frac{(5+12)\times 18\div 3-16}{4}$
	[=]	462.25	answer

7 trigonometric calculation

Problem 7	Key	Display	Note
sin 63° =	[N] 63 [sin]	0.891006524	answer
tan 23°45′.5 =	23.455 [tan]	0.440184145	answer

8 inverse trigonometric calculation

Problem 8	Key	Display	Note
$\cos^{-1}$ 0.5 =	[N] .5 [F] [$\cos^{-1}$]	60.000	answer 60°00′.0
$\sin^{-1}$ 0.2 =	.2 [F] [$\sin^{-1}$]	11.322	answer 11°32′.2

Note:
The input/output of trigonometric and inverse trigonometric function calculations is given as follows.
11→ degrees 32→minutes 2→1/10 minutes

9 square root calculation

Problem 9	Key	Display	Note
$\sqrt{5} + \sqrt{3} =$	[N] 5 [F] [√] [+]	2.236067977	$\sqrt{5}$
	3 [F] [√] [=]	3.968118784	answer

10 trigonometric and square root calculation

Problem 10	Key	Display	Note
sin 30° + $\sqrt{5}$ − cos 25°45′.5 =	[N] 30 [sin] [+]	0.5	sin 30°
	5 [F] [√]	2.236067977	$\sqrt{5}$
	[−]	2.736067977	sin 30° + $\sqrt{5}$
	25.455 [cos]	0.900635042	cos 25°45′.5
	[=]	1.835432935	answer

CORRECTION OF MISTAKES

When a false number is entered during calculation, press the [CE] Key; then, only the false number is cleared.

Key	Display	Note
123 [+] 455	455.	False number 455
[CE]	0.	is cleared
456 [=]	579.	Answer 123 + 456

If the arithmetic calculation keys ([×] [÷] [+] [−]) are operated by mistake, press the correct key successively; then, the correct instruction replaces the preceding instruction.

Key	Display	Note
7 [×]	7.	False instruction
[÷]	7.	correction of the instruction
8 [=]	0.875	Answer 7 ÷ 8

OVERFLOW ERROR

An overflow error will occur in the following cases. When an overflow error is detected, all keys electronically are interlocked except the [C] key.
Overflow error is cleared by pressing the [C] key.

1. When the integer portion of sum, difference, product or quotient exceeds 10 digits.
2. When a number is divided by zero.
3. When x value in the function calculation is in the following cases:
   $\sqrt{x}$ .... $x < 0$ tan x .... $x = 90\,(2n + 1)$ $(n = 0, \pm 1, \pm 2.)$ $\sin^{-1}x$, $\cos^{-1}x$ .... $|x| > 1$
4. In ▶ARC mode when an entered number exceeds 666666666.5
5. In DR mode when | D.R. Lat |>90°
6. In FIX mode when| Fix Lat |>90° |Fix Long |>360°
7. In Vertex of GC mode when Departing Lat. = Arriving Lat. = 0° or Departing Long = Arriving Long.
8. In Navigation mode when any one of the conditions stated in above 1, 2 or 3 occurs.

(Note) In all the cases 1 to 8, the memory retains the contents before the overflow error is detected

BLOCKING OF INCORRECT DATA ENTRY

In the following cases if obviously wrong data is attempted to be entered, the program blocks it, and asks the re-entry of correct data without having to go back to the very beginning.

In SAC and VAC mode when Sun's S.D. > 1, Moon's H.P. >2, planets' HP >0.1

HOW TO INSERT AND REPLACE BATTERIES

1. Turn off the power switch and remove the battery compartment cover by pushing gently in the direction indicated by the arrow (fig. 1).
2. Insert four type SUM-3E batteries or Ni-Cd battery pack (EA-19B) (fig. 1, fig. 2).
   At this time set them to the spring side ("—" side) first while noting their polarities.
3. Slide the battery compartment cover into the main body after setting the pawls on the right and left sides of the former to the grooves in the latter.
4. When display begins fading, it means that batteries are exhausted. Therefore, replace the batteries with new ones (in the case of Ni-Cd battery recharge it).
   - When replacing the batteries with new ones, replace all of four batteries at the same time.
   - When inserting or pulling the plug of AC adaptor into or from NC-77, be sure to turn off the power switch of the computer.

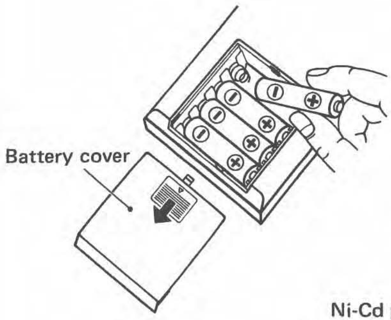


fig. 1

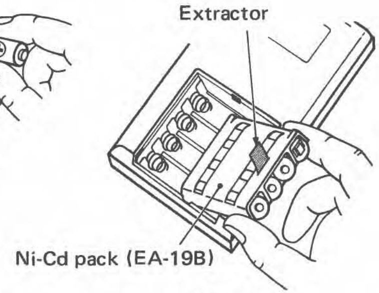


fig. 2

SPECIFICATIONS

Power Source:	AC: with Adaptor/Charger EA-14A (Option) for 100, 110, 220V, 50/60 Hz DC: 6V 1.5V x 4 SUM 3E (Standard) 3.6V Rechargeable Ni-Cd battery EA-19B (Option) DC: 12V-24V DC Adaptor (Option)
Operating Hours:	10 hours by SUM 3E battery 6 hours by EA-19B Ni-Cd battery (charge 15 hours)
Display Method:	Fluorescent (Itron) display with zero suppression
Display Capacity:	14 digits: 2 digits Symbol Sign, 1 digit space, 1 digit minus sign, 10 digits input/output.
Decimal Point:	Fully floating decimal point
Calculations:	four arithmetic calculations, constant calculations, chain multiplication & division, square and power calculation, reciprocal calculation, mixed calculation, memory calculation
Scientific Functions:	sin x, cos x, tan x, $\sin^{-1}$x, $\cos^{-1}$x, $\tan^{-1}$x, $\sqrt{\ }$
Programmed Navigation Functions:	Nautical Almanac, Proportional Parts, Altitude and Azimuth for celestial Line of Position, Fix, Dead Reckoning/Course and Distance by Mercator Sailing or Parallel Sailing, Course and Distance by Great Circle Sailing, Vertex, Latitude on Great Circle Track, True Wind Direction and Speed, Navigation Through a Current 1.2 and 3, Traverse Sailing, Height of Tide, Velocity of Stream, Standard and Variable Sextant Altitude Corrections, Lat. and Long. by Sun's Meridian Passage, Distance to Object, h.ms $\rightleftarrows$ h.hh conversion for Speed, Time and Distance Computation. Hours, minutes, seconds calculation, degrees, minutes, 1/10 minute calculation, degrees, minutes, 1/10 minute $\rightleftarrows$ hours, minutes, seconds conversion.
Memory:	2 user accessible memories, and 2 extra memories for the output of ALM, FIX, LOP, CD, DR, WDS, CU1, 2, 3, and MPS.
Components:	LSI, etc.
Operating Temperature:	0 – 40°C (32 – 104°F)
Power Consumption:	DC: 0.8W
Dimensions:	82 (W) x 27 (H) x 150 (D)mm, 3-1/4" (W) x 1-1/8" (H) x 5-1/2" (D)
Weight:	250 grams (0.55 lbs.)
Protection case:	Hand-made felt-lined wooden box.